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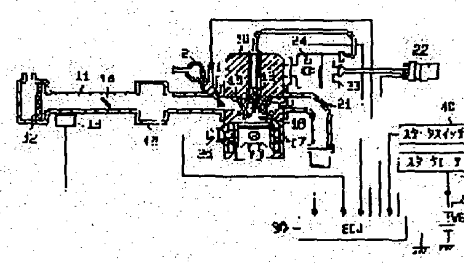
(54) FUEL INJECTION CONTROL DEVICE OF INTERNAL COMBUSTION ENGINE

(57)Abstract:
PROBLEM TO BE SOLVED: To accurately control the fuel injection amount at the starting time of an engine.
SOLUTION: ECU 30 calculates the starting time fuel amount according to the engine water temperature, in the process from the first explosion to the final explosion of an engine 10, and at the same time, it corrects the starting time fuel amount to the increasing side, as the engine rotation frequency is the lower. And, in such a fuel amount correction, the correcting amount (the rotation correcting coefficient) is increased or decreased according to the increasing degree of the engine rotation frequency at each time. Actually, the rotation correcting coefficient is increased or decreased according to the water temperature. Consequently, even though in the case engine friction becomes larger at the engine starting time in a very low temperature, for example, when the engine rotation frequency increasing level at the engine starting time is charged, the required fuel amount according to the friction can be injected and fed, so as to obtain a desired output torque constantly.



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CLAIMS

[Claim(s)]
[Claim 1] A rotational frequency detection means to be the fuel-injection control unit which controls the fuel oil consumption at the time of starting of an internal combustion engine characterized by providing the following, and to detect an engine rotational frequency, and process until the aforementioned internal combustion engine results [from first **] in high-order detonation. It is a fuel quantity calculation means at the time of starting which computes fuel quantity at the time of starting. It is the amendment means of amendment 1st to a fuel quantity increase-in-quantity-side at the time of starting whose engine rotational frequency carried out [aforementioned] calculation of the low in process until the aforementioned internal combustion engine similarly results [from first **] in high-order detonation. The 2nd amendment means which makes the amount of amendments concerned fluctuate according to the elevation degree of the occasional engine rotational frequency on the occasion of the fuel quantity amendment by the amendment means of the above 1st.
[Claim 2] The amendment means of the above 2nd is the fuel-injection control unit of the internal combustion engine according to claim 1 which is what makes small the difference of the increase and decrease of width of face of the amount of amendments by the difference in a rotational frequency elevation degree, so that it becomes the high-order detonation nearness of the aforementioned internal combustion engine.
[Claim 3] The amendment means of the above 2nd is the fuel-injection control unit of the internal combustion engine according to claim 1 which is what enlarges gradually the difference of the increase and decrease of width of face of the amount of amendments by the difference in a rotational frequency elevation degree in connection with the passage of time from first ** of the aforementioned internal combustion engine, and makes small gradually the difference of the increase and decrease of width of face of the amount of amendments by the difference in a rotational frequency elevation degree, so that it becomes high-order detonation nearness after that.
[Claim 4] It is the fuel-injection control unit of the internal combustion engine according to claim 1 to 3 with which it has a temperature detection means to detect engine temperature, and the engine temperature the amendment means of the above 2nd carried out [temperature / aforementioned] detection enlarges the amount of amendments by the amendment means of the above 1st noting that the elevation degree of the aforementioned rotational frequency is as small as a low.
[Claim 5] The amendment means of the above 1st is the fuel-injection control unit of an internal combustion engine given in a fuel quantity increase-in-quantity-side at either the amendment claim 1 - the claim 4 at the time of starting which replaced with the engine rotational frequency, and carried out [aforementioned] calculation using the number of combustion cycles from the time of engine starting, so that there were few cycles concerned.
[Claim 6] The amendment means of the above 1st is the fuel-injection control unit of an internal combustion engine given in a fuel quantity increase-in-quantity-side at either the amendment claim 1 - the claim 4 at the time of starting which replaced with the engine rotational frequency, and carried out [aforementioned] calculation using the valve-opening time of an inhalation-of-air bulb, so that the valve-opening time of the bulb concerned was long.
[Claim 7] Process until it is the fuel-injection control unit which controls the fuel oil consumption at the time of starting of an internal combustion engine characterized by providing the following and the aforementioned internal combustion engine results [from first **] in high-order detonation. It is a fuel quantity calculation means at the time of starting which computes fuel quantity according to engine temperature at the time of starting. A fuel quantity amendment means to make the amount of amendments of fuel quantity fluctuate each time according to the elevation degree of an engine rotational frequency in process until it amends fuel quantity according to an engine rotational frequency at the time of starting which carried out [aforementioned] calculation and the aforementioned internal combustion engine results [from first **] in high-order detonation at the time of starting.
[Claim 8] The fuel-injection control unit of the internal combustion engine according to claim 1 to 7 further equipped

with a high-order detonation judging means to judge whether the aforementioned internal combustion engine resulted in high-order detonation, and a high-order detonation decision value setting means to set up the high-order detonation decision value by the aforementioned high-order detonation judging means according to engine temperature.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the fuel-injection control unit for starting the fuel-injection control unit of an internal combustion engine, especially controlling fuel oil consumption suitably in the period from the time of engine starting to high-order detonation.
[0002]
[Description of the Prior Art] The technology of setting up the fuel oil consumption by the injector according to engine temperature (temperature of cooling water) at the time of starting of an internal combustion engine is known conventionally. This is an amendment thing at a fuel oil consumption increase-in-quantity [at the time of an engine's low-temperature starting]-side, and increase-in-quantity amendment of such fuel is carried out in order to mainly compensate shortage of wall surface adhesion of fuel and an evaporation operation.
[0003] Moreover, similarly in the time of starting of an internal combustion engine, amendment technology is known in fuel oil consumption according to the engine rotational frequency that injection supply of the demand fuel quantity according to the occasional engine rotational frequency should be carried out at the engine concerned.
[0004]
[Problem(s) to be Solved by the Invention] However, the problem shown below is invited with the above-mentioned conventional existing technology. That is, at the time of an engine's starting, there is a fact that the engine rotational frequency after first ** does not rise uniquely, from the influence of the engine friction (friction of the piston sliding section etc.) corresponding to engine temperature. For example, at the time of low-temperature starting, friction is large, to a thing with the comparatively slow rotational frequency elevation after first **, at the time of elevated-temperature restart, friction is small, and the rotational frequency elevation after first ** will become comparatively early. Incidentally, it is thought that the above-mentioned friction is proportional to factors, such as kinematic viscosity of an engine oil, mostly.
[0005] If engine friction is different in this case, the elevation degrees of an engine rotational frequency will differ and the actual demand fuel quantity for acquiring high-order detonation torque will also change. Therefore, on the occasion of rotational frequency amendment of fuel oil consumption, accurate fuel-injection control was not able to be carried out with the existing technology of performing most important amendment, without taking engine friction into consideration. Moreover, since the fuel oil consumption which is proportional to engine temperature in every rotation region was set up on the occasion of rotational frequency amendment, fuel-injection control which followed an actual rotation change was not able to be carried out.
[0006] The place which this invention is made paying attention to the above-mentioned problem, and is made into the purpose is offering the fuel-injection control unit of the internal combustion engine which can control the fuel oil consumption at the time of engine starting with a sufficient precision.
[0007]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, invention according to claim 1 In a rotational frequency detection means to detect an engine rotational frequency, and process until the aforementioned internal combustion engine results [from first **] in high-order detonation In process until the aforementioned internal combustion engine results [from first **] in high-order detonation as well as a fuel quantity calculation means at the time of starting which computes fuel quantity at the time of starting It is characterized by having the amendment means of amendment 1st, and the 2nd amendment means which makes the amount of amendments concerned fluctuate according to the elevation degree of the occasional engine rotational frequency on the occasion of the fuel quantity amendment by the amendment means of the above 1st at a fuel quantity increase-in-quantity-side at the time of starting whose engine rotational frequency carried out [aforementioned] calculation of the low.

[0008] In short, generally in a period until it results [from first ** of an internal combustion engine] in high-order detonation, the operation and amendment of fuel quantity are carried out according to engine temperature or an engine rotational frequency at the time of starting. If engine friction is different in this case, the elevation degrees of the engine rotational frequency just behind first ** will differ, and the demand fuel quantity for obtaining the output torque (high-order detonation torque) of a request required for high-order detonation will also change. Then, in this invention, the engine rotational frequency carried out to a low making the fuel quantity concerned fluctuate with an amendment according to the elevation degree of the occasional engine rotational frequency to a fuel quantity increase-in-quantity-side at the time of starting in process until it results [from first **] in high-order detonation. Thereby, even if it is a case so that engine friction may become large at the time of engine starting in very low temperature, the injection supply of the demand fuel quantity according to the friction can be carried out, and a desired output torque is always obtained. That is, unlike the conventional existing equipment which had set up the fuel oil consumption only proportional to engine temperature (engine water temperature), on the occasion of rotational frequency amendment of fuel oil consumption, an output torque required originally is always obtained. Consequently, the fuel oil consumption at the time of engine starting is controllable with a sufficient precision.
[0009] Incidentally, in this specification, "first **" means the state where combustion within a cylinder is started after grant of the initial rotation by the starter motor etc., and "high-order detonation" means the state where an internal combustion engine can maintain rotation now by itself.
[0010] In invention according to claim 2, the amendment means of the above 2nd makes small the difference of the increase and decrease of width of face of the amount of amendments by the difference in a rotational frequency elevation degree, so that it becomes the high-order detonation nearness of the aforementioned internal combustion engine. That is, since it is close to the state where the engine concerned can maintain rotation by himself just before an internal combustion engine results in high-order detonation (high-order detonation rotational frequency), the amendment (amendment by the amendment means of the above 2nd) according to the difference in a rotational frequency elevation degree is so necessary less. Therefore, in high-order detonation nearness, the difference of the amount of amendments of fuel quantity is made small regardless of the grade of the engine friction of the time of starting at the time of starting.
[0011] Moreover, in invention according to claim 3, the amendment means of the above 2nd enlarges gradually the difference of the increase and decrease of width of face of the amount of amendments by the difference in a rotational frequency elevation degree in connection with the passage of time from first ** of the aforementioned internal combustion engine, and it makes small gradually the difference of the increase and decrease of width of face of the amount of amendments by the difference in a rotational frequency elevation degree, so that it becomes high-order detonation nearness after that. According to this composition, fuel quantity control until it results in a high-order detonation state at the time of engine starting from which a rotational frequency elevation degree differs each time can carry out proper.
[0012] In invention according to claim 4, as for the amendment means of the above 2nd, engine temperature enlarges the amount of amendments by the amendment means of the above 1st noting that the elevation degree of the aforementioned rotational frequency is as small as a low. That is, if engine temperature (for example, engine water temperature) is low and the influence of friction is large, demand fuel quantity until the elevation degree of an engine rotational frequency is small and results in a high-order detonation state will also increase. Therefore, if it is made to make fuel quantity fluctuate according to engine temperature at the time of starting, fuel oil consumption according to the difference in a rotational frequency elevation degree can be controlled on parenchyma, and the output torque according to friction can be taken out from an internal combustion engine.
[0013] Moreover, this invention is given to the desired purpose, even if it takes shape like the following claims 5 and 6. Namely, in invention given in the - claim 5, the amendment means of the above 1st is amended to a fuel quantity increase-in-quantity-side at the time of starting which replaced with the engine rotational frequency, and carried out [aforementioned] calculation using the number of combustion cycles from the time of engine starting, so that there were few cycles concerned. - Amend the amendment means of the above 1st to a fuel quantity increase-in-quantity-side in invention given in a claim 6 at the time of starting which replaced with the engine rotational frequency, and carried out [aforementioned] calculation using the valve-opening time of an inhalation-of-air bulb, so that the valve-opening time of the bulb concerned was long.
[0014] In process until, as for invention according to claim 7, the aforementioned internal combustion engine results [from first **] in high-order detonation on the other hand At the time of starting which computes fuel quantity according to engine temperature at the time of starting, a fuel quantity calculation means, In process until it amends fuel quantity according to an engine rotational frequency at the time of starting which carried out [aforementioned] calculation and the aforementioned internal combustion engine results [from first **] in high-order detonation, it is

characterized by having a fuel quantity amendment means to make the amount of amendments of fuel quantity fluctuate according to the rise degree of an engine rotational frequency at the time of starting each time.

[0015] According to the composition of this claim 7, even if it is a case so that engine friction may become large like the above-mentioned claim 1 at the time of engine starting in very low temperature, the injection supply of the demand fuel quantity according to the friction can be carried out, and a desired output torque is obtained. Consequently, the fuel oil consumption at the time of engine starting is controllable with a sufficient precision.

[0016] In invention according to claim 8, it has further a high-order detonation judging means to judge whether the aforementioned internal combustion engine resulted in high-order detonation, and a high-order detonation decision value setting means to set up the high-order detonation decision value by the aforementioned high-order detonation judging means according to engine temperature. That is, the rotational frequency to which an internal combustion engine can maintain rotation by itself changes with engine temperature in practice. Specifically, the rotational frequency of high-order detonation becomes high, so that engine temperature is low. Proper fuel-oil-consumption control is continuable in a period until it actually reaches the bottom of such the actual condition at high-order detonation according to the above-mentioned composition.

[0017]

[Embodiments of the Invention] Hereafter, the form of the 1 operation which materialized this invention is explained according to a drawing. The fuel-injection control unit in the form of this operation is in the system which controls the fuel oil consumption to an engine by the electronic control (henceforth ECU) which makes a well-known microcomputer a subject, and is related with the equipment which controls the fuel oil consumption at the time of engine starting proper especially. First, with reference to this drawing 1 , the composition of the internal combustion engine with which the equipment and this equipment of a form of this operation are applied is explained.

[0018] an engine 10 -- the 1- consisting of a 4-cylinder jump-spark-ignition formula internal combustion engine which has the 4th (#1-#4) four cylinder, the combustion sequence has become #1 ->#3 ->#4 ->#2 The injector 1 is arranged in each by the cylinder like illustration. Distribution supply of the fuel fed from the fuel-supply system which is not illustrated is carried out through a delivery pipe 2 at the injector 1 of each cylinder. By carrying out the valve-opening drive only of the time corresponding to the fuel oil consumption ordered by ECU30 in this injector 1, injection supply of the fuel is carried out at these each corresponding cylinders.

[0019] On the other hand, the fuel by which injection supply was carried out with the injector 1 is mixed with the air inhaled through the air cleaner 12, the throttle valve 14, and surge tank 15 which are formed in the inlet pipe 11 of an engine 10. And this gaseous mixture is introduced into the combustion chamber 18 in a cylinder 17 through the inhalation-of-air bulb 16.

[0020] Here, a throttle valve 14 is a bulb which adjusts the amount of the air which is interlocked with the accelerator pedal which vehicles do not illustrate, is inhaled by the above-mentioned inlet pipe 11, and is mixed with injection fuel. Moreover, the surge tank 15 is arranged in order to suppress pulsation of the air inhaled through this throttle valve 14.

[0021] The gaseous mixture introduced into the combustion chamber 18 in the above-mentioned cylinder 17 is compressed in it, by emitting ignition sparks from an ignition plug 19, is lit and explodes. An engine 10 acquires rotation torque by this explosion. Moreover, the gas after combustion is discharged by the exhaust pipe 21 through the exhaust air bulb 20 as exhaust gas. In addition, an ignition plug 19 generates the above-mentioned ignition sparks by impression of the high voltage in which a pressure up is carried out by the ignition coil 22 and which is distributed for every cylinder by the distributor 23.

[0022] The starter motor 28 gives initial rotation to the engine 10 at the time of starting, and carries out a rotation drive in response to electric supply according to ON operation of a starting switch 40 from a battery 50.

[0023] On the other hand, with the above-mentioned equipment, the operational status of an engine 10 is detected through the various following sensors. The air flow meter 13 is arranged by the inlet pipe 11, and this air flow meter 13 measures the amount (the amount of inhalation of air) of the air inhaled by the inlet pipe 11. The rotational frequency sensor 24 is arranged by the distributor 23, and this sensor 24 detects the rotational frequency and angle of rotation of an engine 10. Here, the rotational frequency sensor 24 outputs a pulse-like angle-of-rotation signal (NE pulse) for every 30-degreeCA. Moreover, the coolant temperature sensor 26 is arranged by the cylinder 17 (water jacket) of an engine 10, and this sensor 26 detects the temperature of an engine cooling water. Each output of each [these] sensor is incorporated by ECU30.

[0024] ECU30 detects control parameters, such as the amount of inhalation of air, engine-speed NE, and water temperature Tw, based on the detection output by the various above-mentioned sensors 13, 24, and 26, and calculates the fuel oil consumption (time) and ignition timing to an engine 10 based on these data. And based on the above-mentioned result of an operation, the drive of the above-mentioned injector 1 or an ignition coil 22 is controlled.

[0025] Moreover, the operation information (ON/OFF) on a starting switch 40 is also incorporated by ECU30. In ECU30, the existence of starting operation of an engine 10 is judged based on the operation information on this starting switch 40. In addition, ECU30 receives electric supply from a battery 50, and performs various kinds of control including the fuel-injection control later mentioned by the battery voltage VB.
[0026] Next, an operation of the fuel-injection control unit constituted is explained like the above. Drawing 2 is a flow chart which shows a fuel-injection control routine, and this routine is performed by ECU30 for every NE pulse and every 30-degreeCA.
[0027] Now, if the routine of drawing 2 starts, ECU30 will distinguish first whether the high-order detonation flag XST is "0" at Step 101. The high-order detonation flag XST means whether the engine 10 after starting resulted in high-order detonation, and shows, respectively that XST=1 is after high-order detonation about XST=0 being before high-order detonation. Incidentally, the flag concerned is initialized by "0" at the beginning [to ECU30] of powering on.
[0028] If it is XST=0, ECU30 will progress to Step 102 and will read the various information which the fuel-injection control at the time of engine starting takes. That is, engine-speed NE detected by the aforementioned rotational frequency sensor 24, the water temperature Tw detected by the aforementioned coolant temperature sensor 26, others, and battery voltage VB are read.
[0029] Then, ECU30 carries out map reference of the high-order detonation judging rotational frequency STBNE at Step 103. Specifically according to the relation of drawing 3 , the high-order detonation judging rotational frequency STBNE according to the occasional water temperature Tw is set up. According to drawing 3 , at Tw<-20 degree C, STBNE=600rpm is set up at Tw=-20-0 degree C, and STBNE=400rpm is set up for STBNE=800rpm by Tw>0 degree C, respectively.
[0030] Then, ECU30 carries out size comparison of the aforementioned engine speed NE and the high-order detonation judging rotational frequency STBNE at Step 104. If it is NE<STBNE, ECU30 will regard it as high-order detonation before, will carry out negative distinction of Step 104, and will progress to Step 105. ECU30 carries out map reference of the fuel quantity TAUST using the relation of drawing 4 at the time of starting at Step 105. According to drawing 4 , the big value as fuel quantity TAUST is set up at the time of starting, so that water temperature Tw is low. In addition, with the form of this operation, it considers as the numeric value which carried out the time conversion of the demand fuel quantity, and it is supposed that fuel quantity TAUST is treated at the time of starting (a unit is [msec]).
[0031] Moreover, ECU30 carries out map reference of the spin compensation coefficient KNEST using the relation of drawing 5 at continuing Step 106. According to drawing 5 , the spin compensation coefficient KNEST is computed according to the occasional water temperature Tw and occasional engine speed NE.
[0032] While the big value as a spin compensation coefficient KNEST will be set up so that an engine speed NE is low in the rotation region before high-order detonation (for example, NE<=800rpm) if drawing 5 is explained in full detail here, two or more ultimate lines for setting up the KNEST value concerned are set up according to water temperature Tw. With the form of this operation, a KNEST value is set up in "1-4." The ultimate lines L1, L2, and L3 in drawing correspond to more than Tw=0 degree C, Tw=-20-0 degree C, and Tw=-40--20 degree C, respectively. These ultimate lines L1-L3 are made to correspond to engine friction being different according to water temperature Tw, and since friction becomes large so that water temperature Tw is low, a KNEST value becomes large. According to drawing 5 , from the difference in engine friction, when NE rise degree at the time of engine starting does not become fixed (i.e., when NE rise degree at the time of first ** is comparatively small at for example, the time of very low temperature), fuel quantity amendment according to the NE rise degree can be carried out.
[0033] Moreover, ECU30 computes fuel oil consumption TAU [msec] using the following formula (1) at Step 107, and once ends this routine after that.
TAU=TAUST-KNEST-Kst -- (1)
Here, "Kst" of a formula (1) is a correction factor about water temperature Tw or parameters other than engine-speed NE, for example, the correction factor by battery voltage VB is equivalent to it.
[0034] On the other hand, if it is NE>=STBNE, it will consider that ECU30 resulted in high-order detonation, affirmation distinction of Step 104 will be carried out, and it will progress to Step 108. ECU30 computes the TAU value after starting at continuing Step 109 while setting "1" to the high-order detonation flag XST at Step 108. At this time, while the basic injection quantity is computed by general according to an engine speed NE and an engine load (the amount of inhalation of air), air-fuel ratio amendment etc. is carried out by it to the basic injection quantity concerned, and a TAU value is computed.
[0035] After setting "1" to the high-order detonation flag XST, negative distinction of the aforementioned step 101 is carried out each time, and ECU30 progresses to the direct step 109 from Step 101, and computes the TAU value after starting (the usual fuel-injection control is carried out).

[0036] Drawing 6 is a timing diagram which shows the above-mentioned control action more concretely. Fuel-injection operation of the time of the starting is shown in drawing 6 at the time of low-temperature starting of an engine 10 (in the case of about Tw=-40--20 degree C). In addition, the crank angle counter of this drawing is a counter counted up for every (every 30-degreeCA) NE pulse, and is cleared by "0" for every (every cycle) 720-degreeCA which combustion of each cylinder of #1-#4 completes briefly. Counting of this counter is carried out within the limits of "0-24." however, the counting -- although operation is carried out by the TAU calculation routine of aforementioned drawing 2 , it is omitting the illustration in aforementioned drawing 2

[0037] The injection signal to each cylinder is outputted in order of [ECU /30] #1 ->#3 ->#4 ->#2. The high-order detonation flag XST is initialized by "0" at the beginning of engine starting. An engine speed NE is in a minute rotation region at the time of cranking by the starter motor 28, according to the routine of aforementioned drawing 2 , fuel quantity TAUST and the spin compensation coefficient KNEST calculate at the time of starting, and fuel oil consumption TAU is set up based on this TAUST value and KNEST value (Steps 105-107 of drawing 2). In addition, the spin compensation coefficient KNEST is held at maximum (=4) at this time of engine starting (refer to aforementioned drawing 5).

[0038] If it results in first ** at the time t1 of drawing, an engine speed NE will begin to go up and the spin compensation coefficient KNEST will decrease in response to this NE elevation. That is, the spin compensation coefficient KNEST begins to decrease according to the relation of aforementioned drawing 5 , and the quantity of fuel oil consumption TAU is gradually decreased compared with the time of starting. Since it is Tw=-40--20 degree C at this time, a KNEST value is set up based on the ultimate lines L3 of drawing 5 .

[0039] And "1" will be set to the high-order detonation flag XST if an engine speed NE reaches the high-order detonation rotational frequency STBNE (it is 800rpm in this case). After a flag set is replaced with the fuel-injection control at the time of starting, and the usual fuel-injection control is carried out (Step 109 of drawing 2).

[0040] On the other hand, engine friction becomes comparatively small when engine starting is carried out in the Tw>=0 degree C state. Therefore, as a two-dot chain line shows to drawing 6 , it becomes larger (when it is a solid line) than the case where the elevation degree of the engine speed NE just behind first ** (time [t1] after) is Tw=-40--20 degree C. According to the relation of aforementioned drawing 5 this case, the spin compensation coefficient KNEST is set up based on ultimate lines L1, and the KNEST value concerned is set up more smallish than o'clock of the Tw=-40 - -20-degree-C spin compensation coefficient KNEST (value based on ultimate lines L3). That is, in the case of Tw>=0 degree C, since NE elevation degree after first ** becomes comparatively large, the amendment width of face of an increase-in-quantity amendment sake is set up more smallish in fuel oil consumption TAU.

[0041] In addition, with the form of this operation, Step 105 of aforementioned drawing 2 is equivalent to given in a claim "being a fuel quantity calculation means at the time of starting", and this step 106,107 is equivalent to a "fuel quantity amendment means." Moreover, in the relation of aforementioned drawing 5 used at Step 106 of drawing 2 , the processing whose processing which sets up a KNEST value according to an engine speed NE sets this KNEST value as "the 1st amendment means" according to the ultimate lines L1-L3 for every water temperature Tw is equivalent to "the 2nd amendment means", respectively. Furthermore, Step 103 of drawing 2 is equivalent to a "high-order detonation decision value setting means", and this step 104 is equivalent to a "high-order detonation judging means", respectively.

[0042] According to the form of this operation explained in full detail above, the effect taken below is acquired.

(a) while computing fuel quantity TAUST with the form of this operation according to water temperature Tw in process until an engine 10 results [from first **] in high-order detonation at the time of starting, so that an engine speed NE is low -- the time of starting -- a fuel quantity TAUST increase-in-quantity-side -- an amendment -- it was made like Moreover, it was made to make the amount of amendments concerned (spin compensation coefficient KNEST) fluctuate on the occasion of this fuel quantity amendment according to the rise degree of the occasional engine speed NE.

[0043] In short, if engine friction is different in a period until it results [from first ** of an engine 10] in high-order detonation, NE rise degrees just behind first ** will differ, and the demand fuel quantity for acquiring desired high-order detonation torque will also change. Then, in process until it results [from first **] in high-order detonation, it carried out to lower NE making the spin compensation coefficient KNEST of the fuel quantity TAUST concerned fluctuate with an amendment according to the difference in the occasional NE rise degree to a fuel quantity TAUST increase-in-quantity-side at the time of starting. Specifically, it carried out to making a KNEST value fluctuate according to water temperature Tw.

[0044] Thereby, even if it is a case so that engine friction may become large at the time of engine starting in very low temperature when changing NE rise degree at the time of engine starting namely, the injection supply of the demand fuel quantity according to the friction can be carried out, and a desired output torque is always obtained. That is, unlike

the conventional existing equipment which had set up the fuel oil consumption only proportional to engine water temperature, on the occasion of rotational frequency amendment of fuel oil consumption, an output torque required originally is always obtained. Consequently, the fuel oil consumption at the time of engine starting is controllable with a sufficient precision.

[0045] (b) Width of face between ultimate lines L1 - L3 was gradually made small, so that it became the high-order detonation nearness of an engine 10 while enlarging gradually width of face between ultimate lines L1 - L3 (it is equivalent to "the difference of the increase and decrease of width of face of the amount of amendments") with the rotational frequency elevation from first ** of an engine 10, as shown in the relation of aforementioned drawing 5 . That is, since it is close to the state where the engine 10 concerned can maintain rotation by itself just before high-order detonation of an engine 10, the amendment (proper use of the ultimate lines L1-L3 of aforementioned drawing 5) according to the difference in NE elevation degree is so necessary less. Therefore, in high-order detonation nearness, the grade of amendment of fuel quantity TAUST is made small at the time of starting. According to this composition, fuel quantity control until it results in a high-order detonation state at the time of engine starting from which NE elevation degree differs each time can carry out proper.

[0046] (c) Moreover, the high-order detonation judging rotational frequency STBNE was set as adjustable according to water temperature Tw, and it was presupposed that it judges whether the engine 10 resulted in high-order detonation according to this high-order detonation judging rotational frequency STBNE. In this case, even if the rotational frequency to which an engine 10 can maintain rotation by itself changes with water temperature Tw (engine temperature), in a period until it actually results in high-order detonation, proper fuel-oil-consumption control is continuable.

[0047] (d) When the fuel-injection control at the time of engine starting can carry out proper, the effect that the emission discharge at the time of the starting concerned decreases will also be acquired collectively.

[0048] In addition, the gestalt of operation of this invention is realizable with the following gestalt in addition to the above.

(Another gestalt 1) When the period which combustion of all the cylinders of #1-#4 completes briefly at the time of engine starting, i.e., the period of 720-degreeCA, is made into "1 cycle", it can be tended for every cycle to determine the demand fuel quantity of each cylinder. then, the number of cycles from immediately after starting -- every 720-degreeCA -- counting -- carrying out -- this number of cycles -- responding -- amendment -- counting -- KSYCST is set up

[0049] Specifically, a correction factor KSYCST is computed according to the occasional water temperature Tw and number of cycles using the relation shown in drawing 7 . drawing 7 -- **** -- three -- a ** -- ultimate lines -- L -- one -- ' -- L -- two -- ' -- L -- three -- ' -- water temperature -- Tw -- every (more than Tw=0 degree C, -20-0 degree C, -40--20 degree C) -- setting up -- having -- **** . In each ultimate-lines L1' - L3', the number of cycles used as KSYCST=1 is the number of cycles regarded as the engine 10 having detonated completely. Here, in ultimate-lines L1' with comparatively high water temperature Tw, a smaller KSYCST value is set up in the process (number of cycles = 3) to high-order detonation. Moreover, the KSYCST value comparatively in the process (number of cycles = 5) to high-order detonation at low ultimate-lines L3' with larger water temperature Tw is set up.

[0050] In this case, fuel oil consumption TAU [msec] is computed by the following formula (2).

TAU=TAUST-KSYCST-Kst -- (2)

According to the gestalt of this operation using above-mentioned drawing 7 , from the difference in engine friction, when NE elevation degree at the time of engine starting does not become fixed (i.e., when NE elevation degree at the time of first ** is comparatively small at for example, the time of very low temperature), fuel quantity amendment according to the difference in the NE elevation degree can be carried out.

[0051] In this way, an amendment case, a TAU value does not change suddenly immediately after first ** in the middle of 1 cycle (inside of 720-degreeCA), and an engine 10 can operate the demand [at the number of cycles] fuel quantity at the time of starting by the stable state. In addition, it is also possible to replace with the above-mentioned number of cycles, and to set up a correction factor incidentally, using the number of combustion of each cylinder.

[0052] (Another gestalt 2) It replaces with the gestalt of the above-mentioned implementation which set up the spin compensation coefficient KNEST corresponding to an engine speed NE, and the correction factor KVST corresponding to the valve-opening time [msec] of the inhalation-of-air bulb 16 is set up. That is, a correction factor KVST is set up according to the valve-opening time [msec] of the inhalation-of-air bulb 16 accompanying rotation of a crankshaft.

[0053] Specifically, a correction factor KVST is computed according to the occasional water temperature Tw and bulb valve-opening time using the relation shown in drawing 8 . drawing 8 -- **** -- three -- a ** -- ultimate lines -- L -- one -- " -- L -- two -- " -- L -- three -- " -- water temperature -- Tw -- every (more than Tw=0 degree C, -20-0 degree C,

-40--20 degree C) -- setting up -- having -- **** . Here, it means that it is in a high NE region that bulb valve-opening time is short, and means conversely that bulb valve-opening time has been in a low NE region for a long time.
[0054] In this case, fuel oil consumption TAU [msec] is computed by the following formula (3).
TAU=TAUST-KVST-Kst -- (3)
That is, the relation of drawing 8 transposes the engine speed NE of a horizontal axis to bulb valve-opening time in aforementioned drawing 5 , and it amends it to a fuel quantity increase-in-quantity-side at the time of starting, so that the valve-opening time of a bulb is long. By the above, from the difference in engine friction (water temperature Tw), when NE elevation degree at the time of engine starting does not become fixed, fuel quantity amendment according to the difference in the NE elevation degree can be carried out.
[0055] (Another gestalt 3) The existence of a flame failure is judged based on an engine speed NE at the time of engine starting, for example, it is an increase-in-quantity amendment about fuel oil consumption TAU at the time of a flame failure. In addition to the increase-in-quantity amendment by the aforementioned spin compensation coefficient KNEST and aforementioned correction factors KSYCST and KVST, this is the meaning which amends to an increase-in-quantity side further, and is urged to speeding up of high-order detonation by this increase-in-quantity amendment at the time of a flame failure.
[0056] (Another gestalt 4) This is changed, although it responded to water temperature Tw and asked for the elevation degree of the rotational frequency NE at the time of engine starting with the gestalt of the above-mentioned implementation. For example, engine temperature is presumed based on outside air temperature, the elapsed time from the time of the last engine shutdown, etc., and it responds to the estimate of this engine temperature, and you may make it ask for the elevation degree of the engine speed NE at the time of engine starting. What is necessary is in short, just to make NE elevation degree according to the engine friction at the time of engine starting reflect in fuel-injection control.
[0057] (Another form 5) By the TAU calculation routine of aforementioned drawing 2 , although the high-order detonation judging rotational frequency STBNE was set as adjustable according to water temperature Tw, let this high-order detonation judging rotational frequency STBNE be a fixed value. In this case, the operation load by ECU30 is mitigable by reference processing of a STBNE value being omitted.

[Translation done.]

* NOTICES *

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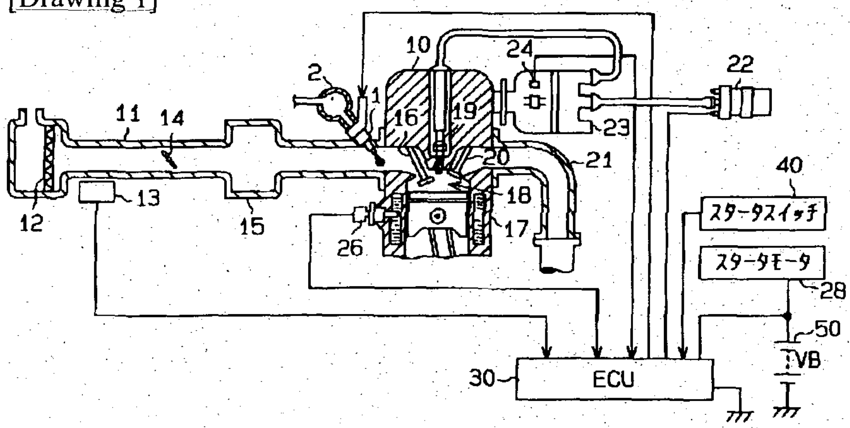
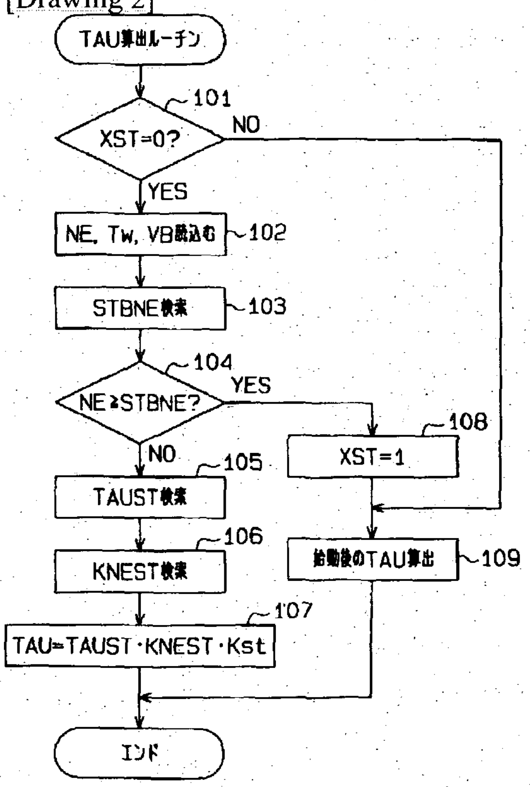
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

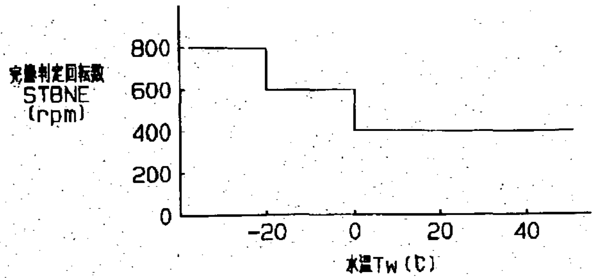
[Drawing 1]



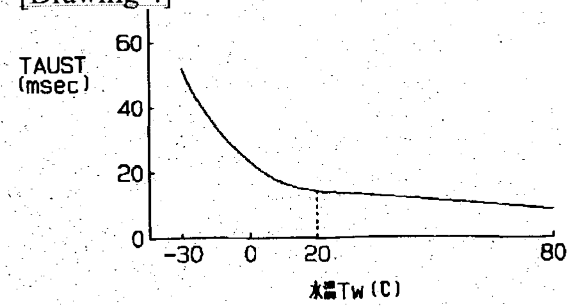
[Drawing 2]



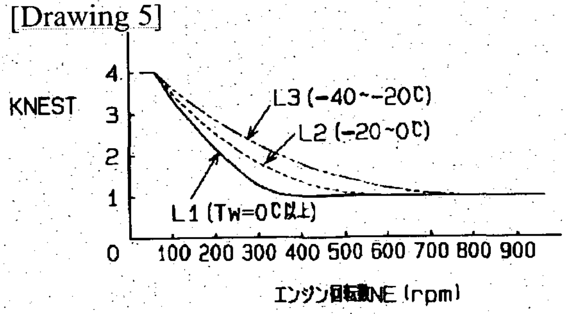
[Drawing 3]



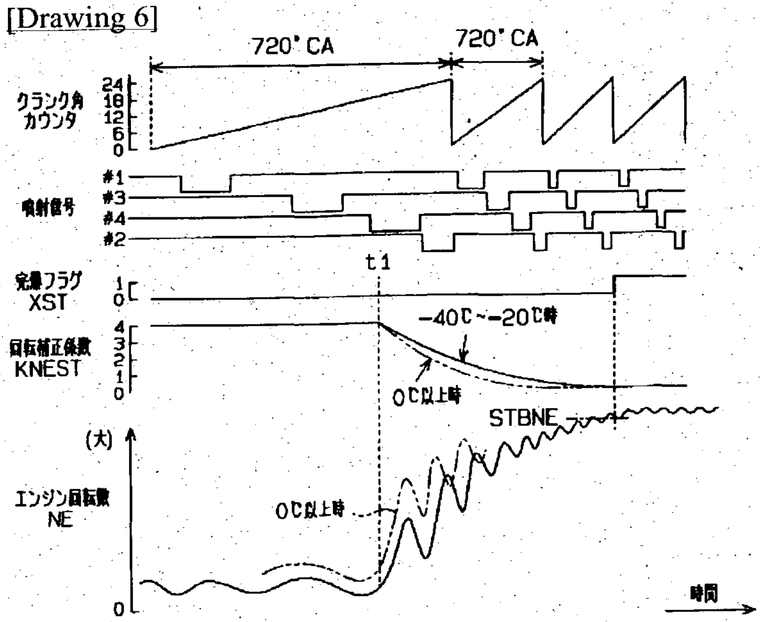
[Drawing 4]



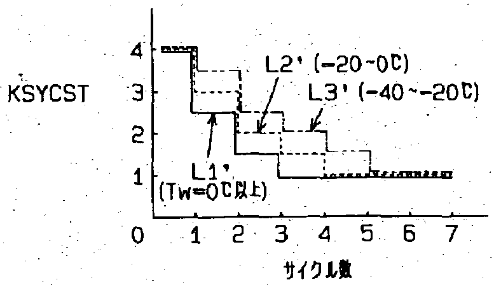
[Drawing 5]



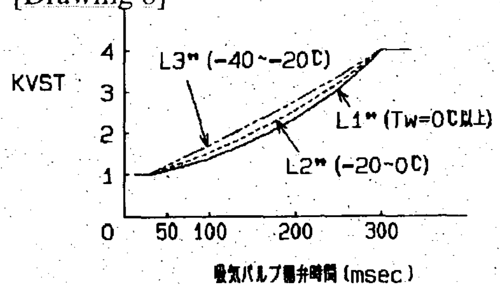
[Drawing 6]



[Drawing 7]



[Drawing 8]



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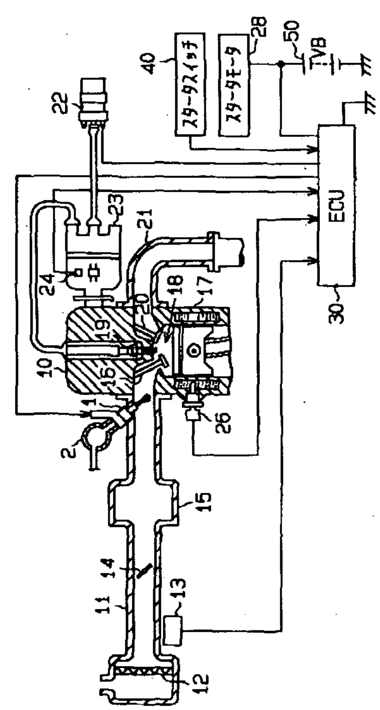
(54)【発明の名称】　内燃機関の燃料噴射制御装置

(57)【要約】

【課題】機関始動時における燃料噴射量を精度良く制御する。

【解決手段】ＥＣＵ３０は、エンジン１０が初爆から完爆に至るまでの過程において、エンジン水温に応じて始動時燃料量を算出すると共に、エンジン回転数が低いほど、始動時燃料量を増量側に補正する。また、かかる燃料量補正に際し、当該補正量（回転補正係数）をその時々のエンジン回転数の上昇度合に応じて増減させる。具体的には、水温に応じて回転補正係数を増減させる。これにより、エンジン始動時の回転数上昇度合が変動する場合、例えば極低温でのエンジン始動時においてエンジンフリクションが大きくなるような場合であっても、そのフリクションに応じた要求燃料量が噴射供給でき、常に所望の出力トルクが得られる。



【特許請求の範囲】
【請求項1】内燃機関の始動時における燃料噴射量を制御する燃料噴射制御装置であって、
機関回転数を検出する回転数検出手段と、
前記内燃機関が初爆から完爆に至るまでの過程において、始動時燃料量を算出する始動時燃料量算出手段と、
同じく前記内燃機関が初爆から完爆に至るまでの過程において、機関回転数が低いほど、前記算出した始動時燃料量を増量側に補正する第1の補正手段と、
前記第1の補正手段による燃料量補正に際し、当該補正量をその時々の機関回転数の上昇度合に応じて増減させる第2の補正手段とを備えることを特徴とする内燃機関の燃料噴射制御装置。
【請求項2】前記第2の補正手段は、前記内燃機関の完爆間近になるほど回転数上昇度合の違いによる補正量の増減幅の差を小さくするものである請求項1に記載の内燃機関の燃料噴射制御装置。
【請求項3】前記第2の補正手段は、前記内燃機関の初爆からの時間の経過に伴い回転数上昇度合の違いによる補正量の増減幅の差を徐々に大きくし、その後、完爆間近になるほど回転数上昇度合の違いによる補正量の増減幅の差を徐々に小さくするものである請求項1に記載の内燃機関の燃料噴射制御装置。
【請求項4】機関温度を検出する温度検出手段を備え、前記第2の補正手段は、前記検出した機関温度が低いほど、前記回転数の上昇度合が小さいとして前記第1の補正手段による補正量を大きくする請求項1～請求項3のいずれかに記載の内燃機関の燃料噴射制御装置。
【請求項5】前記第1の補正手段は、機関回転数に代えて機関始動時からの燃焼サイクル数を用い、当該サイクル数が少ないほど、前記算出した始動時燃料量を増量側に補正する請求項1～請求項4のいずれかに記載の内燃機関の燃料噴射制御装置。
【請求項6】前記第1の補正手段は、機関回転数に代えて吸気バルブの開弁時間を用い、当該バルブの開弁時間が長いほど、前記算出した始動時燃料量を増量側に補正する請求項1～請求項4のいずれかに記載の内燃機関の燃料噴射制御装置。
【請求項7】内燃機関の始動時における燃料噴射量を制御する燃料噴射制御装置であって、
前記内燃機関が初爆から完爆に至るまでの過程において、機関温度に応じて始動時燃料量を算出する始動時燃料量算出手段と、
前記算出した始動時燃料量を機関回転数に応じて補正し且つ、前記内燃機関が初爆から完爆に至るまでの過程においてその都度、始動時燃料量の補正量を機関回転数の上昇度合に応じて増減させる燃料量補正手段とを備えることを特徴とする内燃機関の燃料噴射制御装置。
【請求項8】前記内燃機関が完爆に至ったか否かを判定する完爆判定手段と、
前記完爆判定手段による完爆判定値を機関温度に応じて設定する完爆判定値設定手段とを更に備える請求項1～請求項7のいずれかに記載の内燃機関の燃料噴射制御装置。

【発明の詳細な説明】
【0001】
【発明の属する技術分野】本発明は、内燃機関の燃料噴射制御装置に係り、特に機関始動当初から完爆までの期間において燃料噴射量を好適に制御するための燃料噴射制御装置に関するものである。
【0002】
【従来の技術】内燃機関の始動時において、インジェクタによる燃料噴射量を機関温度（冷却水の温度）に応じて設定する技術が従来より知られている。これは、例えば機関の低温始動時に燃料噴射量を増量側に補正するものであって、こうした燃料の増量補正は、主に燃料の壁面付着や気化作用の不足を補うために実施される。
【0003】また、同じく内燃機関の始動時において、その時々の機関回転数に応じた要求燃料量を当該機関に噴射供給すべく、機関回転数に応じて燃料噴射量を補正する技術も知られている。
【0004】
【発明が解決しようとする課題】ところが、上記従来の既存技術では、以下に示す問題を招来する。つまり、機関の始動時には、機関温度に対応するエンジンフリクション（ピストン摺動部の摩擦など）の影響から、初爆後の機関回転数が一義的に上昇しないという事実がある。例えば低温始動時にはフリクションが大きく、初爆後の回転数上昇が比較的遅いのに対し、高温再始動時にはフリクションが小さく、初爆後の回転数上昇が比較的早いものとなる。因みに、上記フリクションは、エンジンオイルの動粘度などの要因にほぼ比例するものと考えられる。
【0005】かかる場合において、エンジンフリクションが相違すると、機関回転数の上昇度合が異なり、完爆トルクを得るための実際の要求燃料量も変わってくる。従って、燃料噴射量の回転数補正に際し、エンジンフリクションを考慮せずに一義的な補正を行う既存の技術では、精度の良い燃料噴射制御を実施することができなかった。また、回転数補正に際し、どの回転域でも機関温度に比例した燃料噴射量を設定するため、実際の回転変動に追従した燃料噴射制御を実施することができなかった。
【0006】本発明は、上記問題に着目してなされたものであって、その目的とするところは、機関始動時における燃料噴射量を精度良く制御することができる内燃機関の燃料噴射制御装置を提供することである。
【0007】
【課題を解決するための手段】上記目的を達成するために、請求項1に記載の発明は、機関回転数を検出する回

転数検出手段と、前記内燃機関が初爆から完爆に至るまでの過程において、始動時燃料量を算出する始動時燃料量算出手段と、同じく前記内燃機関が初爆から完爆に至るまでの過程において、機関回転数が低いほど、前記算出した始動時燃料量を増量側に補正する第１の補正手段と、前記第１の補正手段による燃料量補正に際し、当該補正量をその時々の機関回転数の上昇度合に応じて増減させる第２の補正手段とを備えることを特徴とする。

【０００８】要するに、内燃機関の初爆から完爆に至るまでの期間では、一般に機関温度や機関回転数に応じて始動時燃料量の演算や補正が実施される。かかる場合、エンジンフリクションが相違すると、初爆直後における機関回転数の上昇度合が異なり、完爆に必要な所望の出力トルク（完爆トルク）を得るための要求燃料量も変わってくる。そこで本発明では、初爆から完爆に至るまでの過程において、機関回転数が低いほど始動時燃料量を増量側に補正すると共に、当該燃料量をその時々の機関回転数の上昇度合に応じて増減させることとした。これにより、例えば極低温での機関始動時にエンジンフリクションが大きくなるような場合であっても、そのフリクションに応じた要求燃料量が噴射供給でき、常に所望の出力トルクが得られる。つまり、燃料噴射量の回転数補正に際し、単に機関温度（エンジン水温）に比例する燃料噴射量を設定していた従来既存の装置とは異なり、本来必要な出力トルクが常に得られる。その結果、機関始動時における燃料噴射量を精度良く制御することができる。

【０００９】因みに本明細書において、「初爆」とは、スタータモータなどによる初期回転の付与後に気筒内での燃焼が開始される状態を意味し、「完爆」とは、内燃機関が自力で回転を維持できるようになる状態を意味する。

【００１０】請求項２に記載の発明では、前記第２の補正手段は、前記内燃機関の完爆間近になるほど回転数上昇度合の違いによる補正量の増減幅の差を小さくする。つまり、内燃機関が完爆（完爆回転数）に至る直前においては、当該機関が自力で回転を維持できる状態に近いため、回転数上昇度合の違いに応じた補正（前記第２の補正手段による補正）がさほど必要でなくなる。従って、完爆間近においては、始動当初のエンジンフリクションの程度に関係なく、始動時燃料量の補正量の差を小さくする。

【００１１】また、請求項３に記載の発明では、前記第２の補正手段は、前記内燃機関の初爆からの時間の経過に伴い回転数上昇度合の違いによる補正量の増減幅の差を徐々に大きくし、その後、完爆間近になるほど回転数上昇度合の違いによる補正量の増減幅の差を徐々に小さくする。本構成によれば、回転数上昇度合がその都度異なる機関始動時において、完爆状態に至るまでの燃料量制御が適正に実施できる。

【００１２】請求項４に記載の発明では、前記第２の補正手段は、機関温度が低いほど、前記回転数の上昇度合が小さいとして前記第１の補正手段による補正量を大きくする。つまり、機関温度（例えばエンジン水温）が低くフリクションの影響が大きいと、機関回転数の上昇度合が小さく、完爆状態に至るまでの要求燃料量も多くなる。従って、機関温度に応じて始動時燃料量を増減させるようにすれば、実質上、回転数上昇度合の違いに応じた燃料噴射量の制御が実施でき、フリクションに応じた出力トルクを内燃機関から取り出すことができる。

【００１３】また、本発明は、次の請求項５，６のように具体化しても所望の目的が達せられる。すなわち、・請求項５に記載の発明では、前記第１の補正手段は、機関回転数に代えて機関始動時からの燃焼サイクル数を用い、当該サイクル数が少ないほど、前記算出した始動時燃料量を増量側に補正する。・請求項６に記載の発明では、前記第１の補正手段は、機関回転数に代えて吸気バルブの開弁時間を用い、当該バルブの開弁時間が長いほど、前記算出した始動時燃料量を増量側に補正する。

【００１４】一方、請求項７に記載の発明は、前記内燃機関が初爆から完爆に至るまでの過程において、機関温度に応じて始動時燃料量を算出する始動時燃料量算出手段と、前記算出した始動時燃料量を機関回転数に応じて補正し且つ、前記内燃機関が初爆から完爆に至るまでの過程においてその都度、始動時燃料量の補正量を機関回転数の上昇度合に応じて増減させる燃料量補正手段とを備えることを特徴とする。

【００１５】本請求項７の構成によれば、上記請求項１と同様に、例えば極低温での機関始動時においてエンジンフリクションが大きくなるような場合であっても、そのフリクションに応じた要求燃料量が噴射供給でき、常に所望の出力トルクが得られる。その結果、機関始動時における燃料噴射量を精度良く制御することができる。

【００１６】請求項８に記載の発明では、前記内燃機関が完爆に至ったか否かを判定する完爆判定手段と、前記完爆判定手段による完爆判定値を機関温度に応じて設定する完爆判定値設定手段とを更に備える。つまり、内燃機関が自力で回転を維持できる回転数は実際上、機関温度によって異なる。具体的には、機関温度が低いほど完爆の回転数は高くなる。こうした実状下において上記構成によれば、実際に完爆に至るまでの期間で適正な燃料噴射量制御が継続できる。

【００１７】

【発明の実施の形態】以下、この発明を具体化した一実施の形態を図面に従って説明する。本実施の形態における燃料噴射制御装置は、周知のマイクロコンピュータを主体とする電子制御装置（以下、ＥＣＵという）により機関への燃料噴射量を制御するシステムにあって、特に機関始動時の燃料噴射量を適正に制御する装置に関する。はじめに、同図１を参照して、本実施の形態の装

置、並びに同装置が適用される内燃機関の構成について説明する。

【0018】エンジン10は、第1～第4（＃1～＃4）の4つの気筒を有する4気筒火花点火式内燃機関からなり、その燃焼順序は＃1→＃3→＃4→＃2となっている。気筒には各々にインジェクタ1が図示の如く配設されている。図示しない燃料供給系から圧送される燃料は、デリバリパイプ2を通じて各気筒のインジェクタ1に分配供給される。該インジェクタ1がECU30により指令される燃料噴射量に対応した時間だけ開弁駆動されることにより、それら各対応する気筒に燃料が噴射供給される。

【0019】一方、インジェクタ1によって噴射供給された燃料は、エンジン10の吸気管11に設けられているエアクリーナ12、スロットルバルブ14及びサージタンク15を介して吸入される空気と混合される。そしてこの混合気は、吸気バルブ16を介してシリンダ17内の燃焼室18に導入される。

【0020】ここで、スロットルバルブ14は、例えば車両の図示しないアクセルペダルに連動して、上記吸気管11に吸入され噴射燃料と混合される空気の量を調節するバルブである。また、サージタンク15は、このスロットルバルブ14を介して吸入される空気の脈動を抑えるために配設されている。

【0021】上記シリンダ17内の燃焼室18に導入された混合気は、その中で圧縮され、点火プラグ19から点火火花が発せられることにより点火して爆発する。エンジン10は、この爆発によって回転トルクを得る。また、燃焼後のガスは、排気ガスとして排気バルブ20を介して排気管21に排出される。なお、点火プラグ19は、点火コイル22により昇圧されて且つ、ディストリビュータ23により気筒毎に分配される高電圧の印加によって上記点火火花を発生する。

【0022】スタータモータ28は、始動時のエンジン10に初期回転を付与するものであって、スタータスイッチ40のON操作に従いバッテリ50より給電を受けて回転駆動する。

【0023】他方、上記装置では、以下のような各種センサを通じて、エンジン10の運転状態を検出する。吸気管11にはエアフローメータ13が配設されており、このエアフローメータ13は吸気管11に吸入される空気の量（吸気量）を測定する。ディストリビュータ23には回転数センサ24が配設されており、同センサ24はエンジン10の回転数並びに回転角を検出する。ここで、回転数センサ24は、30°CA毎にパルス状の回転角信号（NEパルス）を出力する。また、エンジン10のシリンダ17（ウォータージャケット）には水温センサ26が配設されており、同センサ26はエンジン冷却水の温度を検出する。これら各センサの出力は何れも、ECU30に取り込まれる。

【0024】ECU30は、上記各種センサ13，24，26による検出出力をもとに吸気量、エンジン回転数NE、水温Twなどの制御パラメータを検知し、これらのデータに基づいてエンジン10への燃料噴射量（時間）や点火時期を演算する。そして、上記演算結果に基づいて上記インジェクタ1や点火コイル22の駆動を制御する。

【0025】また、ECU30には、スタータスイッチ40の操作情報（ON／OFF）も取り込まれる。ECU30では、このスタータスイッチ40の操作情報に基づいて、エンジン10の始動操作の有無を判断する。なお、ECU30は、バッテリ50から給電を受け、そのバッテリ電圧VBにより後述する燃料噴射制御をはじめとする各種の制御を実行する。

【0026】次に、上記の如く構成される燃料噴射制御装置の作用を説明する。図2は、燃料噴射制御ルーチンを示すフローチャートであって、同ルーチンはNEパルス毎に、すなわち30°CA毎にECU30により実行される。

【0027】さて、図2のルーチンがスタートすると、ECU30は、先ずステップ101で完爆フラグXSTが「0」であるか否かを判別する。完爆フラグXSTは、始動後のエンジン10が完爆に至ったかどうかを表すものであって、XST＝0は完爆前であることを、XST＝1は完爆後であることをそれぞれ示す。因みに、ECU30への電源投入当初は、当該フラグが「0」に初期化されるようになっている。

【0028】XST＝0であれば、ECU30はステップ102に進み、エンジン始動時の燃料噴射制御に要する各種情報を読み込む。つまり、前記回転数センサ24により検出されたエンジン回転数NE、前記水温センサ26により検出された水温Twやその他、バッテリ電圧VBを読み込む。

【0029】その後、ECU30は、ステップ103で完爆判定回転数STBNEをマップ検索する。具体的には、図3の関係に従い、その時々の水温Twに応じた完爆判定回転数STBNEを設定する。図3によれば、Tw＜－20℃ではSTBNE＝800rpmが、Tw＝－20～0℃ではSTBNE＝600rpmが、Tw＞0℃ではSTBNE＝400rpmが、それぞれ設定される。

【0030】その後、ECU30は、ステップ104で前記のエンジン回転数NEと完爆判定回転数STBNEとを大小比較する。NE＜STBNEであれば、ECU30は完爆前とみなし、ステップ104を否定判別してステップ105に進む。ECU30は、ステップ105で例えば図4の関係を用いて始動時燃料量TAUSTをマップ検索する。図4によれば、水温Twが低いほど、始動時燃料量TAUSTとして大きな値が設定される。なお本実施の形態では、要求燃料量を時間換算した数値

として、始動時燃料量ＴＡＵＳＴを扱うこととしている（単位は〔ｍｓｅｃ〕）。

【００３１】また、ＥＣＵ３０は、続くステップ１０６で例えば図５の関係を用いて回転補正係数ＫＮＥＳＴをマップ検索する。図５によれば、その時々の水温Ｔｗとエンジン回転数ＮＥとに応じて回転補正係数ＫＮＥＳＴが算出される。

【００３２】ここで図５を詳述すれば、完爆前の回転域（例えばＮＥ≦８００ｒｐｍ）においてエンジン回転数ＮＥが低いほど、回転補正係数ＫＮＥＳＴとして大きな値が設定されると共に、当該ＫＮＥＳＴ値を設定するための特性線が水温Ｔｗに応じて複数本設定されている。本実施の形態では、「１～４」の範囲でＫＮＥＳＴ値が設定される。図中の特性線Ｌ１，Ｌ２，Ｌ３はそれぞれ、Ｔｗ＝０℃以上、Ｔｗ＝－２０～０℃、Ｔｗ＝－４０～－２０℃に対応している。これら特性線Ｌ１～Ｌ３は、水温Ｔｗに応じてエンジンフリクションが相違することに対応させたものであって、水温Ｔｗが低いほどフリクションが大きくなるためにＫＮＥＳＴ値が大きくなる。図５によれば、エンジンフリクションの違いから、エンジン始動時のＮＥ上昇度合が一定にならないような場合、すなわち例えば極低温時に初爆時のＮＥ上昇度合が比較的小さいような場合にも、そのＮＥ上昇度合に応じた燃料量補正が実施できる。

【００３３】また、ＥＣＵ３０は、ステップ１０７で次の式（１）を用い、燃料噴射量ＴＡＵ〔ｍｓｅｃ〕を算出し、その後本ルーチンを一旦終了する。

$$TAU = TAUST \cdot KNEST \cdot Kst \quad \cdots (1)$$

ここで、式（１）の「Ｋｓｔ」は、水温Ｔｗやエンジン回転数ＮＥ以外のパラメータに関する補正係数であって、例えばバッテリ電圧ＶＢによる補正係数がそれに相当する。

【００３４】一方、ＮＥ≧ＳＴＢＮＥであれば、ＥＣＵ３０は完爆に至ったとみなし、ステップ１０４を肯定判別してステップ１０８に進む。ＥＣＵ３０は、ステップ１０８で完爆フラグＸＳＴに「１」をセットすると共に、続くステップ１０９で始動後のＴＡＵ値を算出する。このとき一般には、エンジン回転数ＮＥとエンジン負荷（吸気量）とに応じて基本噴射量が算出されると共に、当該基本噴射量に対して空燃比補正などが実施され、ＴＡＵ値が算出される。

【００３５】完爆フラグＸＳＴに「1」がセットされた以降は、前記ステップ１０１が毎回否定判別され、ＥＣＵ３０はステップ１０１から直接ステップ１０９に進み、始動後のＴＡＵ値を算出する（通常の燃料噴射制御を実施する）。

【００３６】図６は、上記制御動作をより具体的に示すタイムチャートである。図６には、エンジン１０の低温始動時（Ｔｗ＝－４０～－２０℃程度の場合）において、その始動当初の燃料噴射動作を示している。なお、同図のクランク角カウンタは、ＮＥパルス毎（３０°ＣＡ毎）にカウントアップされるカウンタであって、＃１～＃４の各気筒の燃焼が一通り完了する７２０°ＣＡ毎（１サイクル毎）に「0」にクリアされるようになっている。同カウンタは、「０～２４」の範囲内で計数される。但し、その計数動作は前記図２のＴＡＵ算出ルーチンにて実施されるものであるが、前記図２ではその図示を省略している。

【００３７】各気筒への噴射信号は、＃１→＃３→＃４→＃２の順にＥＣＵ３０より出力される。エンジン始動当初は完爆フラグＸＳＴが「0」に初期化されている。スタータモータ２８によるクランキング時においては、エンジン回転数ＮＥが微小回転域にあり、前記図２のルーチンによれば、始動時燃料量ＴＡＵＳＴ及び回転補正係数ＫＮＥＳＴが演算されてこのＴＡＵＳＴ値やＫＮＥＳＴ値に基づき燃料噴射量ＴＡＵが設定される（図２のステップ１０５～１０７）。なお、このエンジン始動当初には、回転補正係数ＫＮＥＳＴは最大値（＝４）で保持されている（前記図５参照）。

【００３８】図の時刻ｔ１で初爆に至ると、エンジン回転数ＮＥが上昇し始め、このＮＥ上昇を受けて回転補正係数ＫＮＥＳＴが減少する。つまり、前記図５の関係に従い回転補正係数ＫＮＥＳＴが減少し始め、始動当初に比べて燃料噴射量ＴＡＵが徐々に減量される。このとき、Ｔｗ＝－４０～－２０℃であるため、図５の特性線Ｌ３に基づきＫＮＥＳＴ値が設定される。

【００３９】そして、エンジン回転数ＮＥが完爆回転数ＳＴＢＮＥ（この場合は、８００ｒｐｍ）に達すると、完爆フラグＸＳＴに「1」がセットされる。フラグセット後は、始動時の燃料噴射制御に代えて通常の燃料噴射制御が実施される（図２のステップ１０９）。

【００４０】一方、Ｔｗ≧０℃の状態でエンジン始動される場合には、エンジンフリクションが比較的小さくなる。従って、図６に二点鎖線で示すように、初爆直後（時刻ｔ１後）におけるエンジン回転数ＮＥの上昇度合がＴｗ＝－４０～－２０℃の場合（実線の場合）よりも大きくなる。かかる場合、前記図５の関係によれば、特性線Ｌ１に基づいて回転補正係数ＫＮＥＳＴが設定され、当該ＫＮＥＳＴ値はＴｗ＝－４０～－２０℃時の回転補正係数ＫＮＥＳＴ（特性線Ｌ３に基づく値）よりも小さめに設定される。つまり、Ｔｗ≧０℃の場合には、初爆後におけるＮＥ上昇度合が比較的大きくなるため、燃料噴射量ＴＡＵを増量補正するための補正幅が小さめに設定される。

【００４１】なお本実施の形態では、前記図２のステップ１０５が請求項記載の「始動時燃料量算出手段」に相当し、同ステップ１０６，１０７が「燃料量補正手段」に相当する。また、図２のステップ１０６で用いた前記

図５の関係において、エンジン回転数ＮＥに応じてＫＮＥＳＴ値を設定する処理が「第１の補正手段」に、水温Ｔｗ毎の特性線Ｌ１～Ｌ３に応じて同ＫＮＥＳＴ値を設定する処理が「第２の補正手段」にそれぞれ相当する。さらに、図２のステップ１０３が「完爆判定値設定手段」に、同ステップ１０４が「完爆判定手段」にそれぞれ相当する。

【００４２】以上詳述した本実施の形態によれば、以下に示す効果が得られる。

（ａ）本実施の形態では、エンジン１０が初爆から完爆に至るまでの過程において、水温Ｔｗに応じて始動時燃料量ＴＡＵＳＴを算出すると共に、エンジン回転数ＮＥが低いほど、始動時燃料量ＴＡＵＳＴを増量側に補正するようにした。また、かかる燃料量補正に際し、当該補正量（回転補正係数ＫＮＥＳＴ）をその時々のエンジン回転数ＮＥの上昇度合に応じて増減させるようにした。

【００４３】要するに、エンジン１０の初爆から完爆に至るまでの期間において、エンジンフリクションが相違すると、初爆直後におけるＮＥ上昇度合が異なり、所望の完爆トルクを得るための要求燃料量も変わってくる。そこで、初爆から完爆に至るまでの過程において、低ＮＥほど始動時燃料量ＴＡＵＳＴを増量側に補正すると共に、当該燃料量ＴＡＵＳＴの回転補正係数ＫＮＥＳＴをその時々のＮＥ上昇度合の違いに応じて増減させることとした。具体的には、水温Ｔｗに応じてＫＮＥＳＴ値を増減させることとした。

【００４４】これにより、エンジン始動時のＮＥ上昇度合が変動する場合、すなわち例えば極低温でのエンジン始動時にエンジンフリクションが大きくなるような場合であっても、そのフリクションに応じた要求燃料量が噴射供給でき、常に所望の出力トルクが得られる。つまり、燃料噴射量の回転数補正に際し、単にエンジン水温に比例する燃料噴射量を設定していた従来既存の装置とは異なり、本来必要な出力トルクが常に得られる。その結果、エンジン始動時における燃料噴射量を精度良く制御することができる。

【００４５】（ｂ）前記図５の関係に示すように、エンジン１０の初爆からの回転数上昇に伴い特性線Ｌ１～Ｌ３間の幅（「補正量の増減幅の差」に相当する）を徐々に大きくすると共に、エンジン１０の完爆間近になるほど特性線Ｌ１～Ｌ３間の幅を徐々に小さくした。つまり、エンジン１０の完爆直前においては、当該エンジン１０が自力で回転を維持できる状態に近いため、ＮＥ上昇度合の違いに応じた補正（前記図５の特性線Ｌ１～Ｌ３の使い分け）がさほど必要でなくなる。従って、完爆間近においては始動時燃料量ＴＡＵＳＴの補正の程度を小さくする。本構成によれば、ＮＥ上昇度合がその都度異なるエンジン始動時において、完爆状態に至るまでの燃料量制御が適正に実施できる。

【００４６】（ｃ）また、完爆判定回転数ＳＴＢＮＥを水温Ｔｗに応じて可変に設定し、この完爆判定回転数ＳＴＢＮＥに応じてエンジン１０が完爆に至ったか否かを判定することとした。この場合、エンジン１０が自力で回転を維持できる回転数が水温Ｔｗ（機関温度）により異なっても、実際に完爆に至るまでの期間において適正な燃料噴射量制御が継続できる。

【００４７】（ｄ）エンジン始動時の燃料噴射制御が適正に実施できることにより、当該始動時におけるエミッション排出量が減少するという効果も併せて得られることとなる。

【００４８】なお、本発明の実施の形態は、上記以外に次の形態にて実現できる。

（別の形態１）エンジン始動時において、＃１～＃４の全気筒の燃焼が一通り完了する期間、すなわち７２０°ＣＡの期間を「１サイクル」とした場合、各気筒の要求燃料量はサイクル毎に決定できる傾向にある。そこで、始動直後からのサイクル数を７２０°ＣＡ毎に計数し、このサイクル数に応じて補正計数ＫＳＹＣＳＴを設定する。

【００４９】具体的には、図７に示す関係を用い、その時々の水温Ｔｗとサイクル数とに応じて補正係数ＫＳＹＣＳＴを算出する。図７では、３つの特性線Ｌ１’，Ｌ２’，Ｌ３’が水温Ｔｗ毎（Ｔｗ＝０℃以上、－２０～０℃、－４０～－２０℃）に設定されている。各特性線Ｌ１’～Ｌ３’において、ＫＳＹＣＳＴ＝１となるサイクル数はエンジン１０が完爆したとみなされるサイクル数である。ここで、水温Ｔｗが比較的高い特性線Ｌ１’では、完爆までの過程（サイクル数＝３）において、小さめのＫＳＹＣＳＴ値が設定される。また、水温Ｔｗが比較的低い特性線Ｌ３’では、完爆までの過程（サイクル数＝５）において、大きめのＫＳＹＣＳＴ値が設定される。

【００５０】かかる場合、燃料噴射量ＴＡＵ〔ｍｓｅｃ〕は次の式（２）により算出される。

$$TAU = TAUST \cdot KSYCST \cdot Kst \quad \cdots (2)$$

上記図７を用いた本実施の形態によれば、エンジンフリクションの違いから、エンジン始動時のＮＥ上昇度合が一定にならない場合、すなわち例えば極低温時に初爆時のＮＥ上昇度合が比較的小さいような場合にも、そのＮＥ上昇度合の違いに応じた燃料量補正が実施できる。

【００５１】こうしてサイクル数で始動時における要求燃料量を補正する場合、１サイクル途中（７２０°ＣＡ内）での初爆直後にＴＡＵ値が急変することがなく、エンジン１０が安定状態で運転できる。なお因みに、上記サイクル数に代えて各気筒の燃焼数を用いて補正係数を設定することも可能である。

【００５２】（別の形態２）エンジン回転数ＮＥに対応する回転補正係数ＫＮＥＳＴを設定した上記実施の形態に代えて、吸気バルブ１６の開弁時間〔ｍｓｅｃ〕に対

応する補正係数ＫＶＳＴを設定する。つまり、クランク軸の回転に伴う吸気バルブ１６の開弁時間〔ｍｓｅｃ〕に応じて補正係数ＫＶＳＴを設定する。

【００５３】具体的には、図８に示す関係を用い、その時々の水温Ｔｗとバルブ開弁時間とに応じて補正係数ＫＶＳＴを算出する。図８では、３つの特性線Ｌ１”，Ｌ２”，Ｌ３”が水温Ｔｗ毎（Ｔｗ＝０℃以上、－２０～０℃、－４０～－２０℃）に設定されている。ここで、バルブ開弁時間が短いことは高ＮＥ域にあることを意味し、逆にバルブ開弁時間が長いことは低ＮＥ域にあることを意味する。

【００５４】かかる場合、燃料噴射量ＴＡＵ〔ｍｓｅｃ〕は次の式（３）により算出される。

ＴＡＵ＝ＴＡＵＳＴ・ＫＶＳＴ・Ｋｓｔ　　…（３）

つまり、図８の関係は、前記図５において横軸のエンジン回転数ＮＥをバルブ開弁時間に置き換えたものであって、バルブの開弁時間が長いほど、始動時燃料量を増量側に補正する。以上により、エンジンフリクション（水温Ｔｗ）の違いから、エンジン始動時のＮＥ上昇度合が一定にならない場合にも、そのＮＥ上昇度合の違いに応じた燃料量補正が実施できる。

【００５５】（別の形態３）エンジン始動時において、例えばエンジン回転数ＮＥをもとに失火の有無を判定し、失火時には燃料噴射量ＴＡＵを増量補正する。これは、前記の回転補正係数ＫＮＥＳＴ，補正係数ＫＳＹＣＳＴ，ＫＶＳＴによる増量補正に加えて、更に増量側に補正を行う趣旨であり、この増量補正により失火時において完爆の迅速化が促される。

【００５６】（別の形態４）上記実施の形態では、水温Ｔｗに応じてエンジン始動時における回転数ＮＥの上昇度合を求めたが、これを変更する。例えば外気温や前回のエンジン停止時からの経過時間などに基づき機関温度を推定し、この機関温度の推定値に応じてエンジン始動時におけるエンジン回転数ＮＥの上昇度合を求めるようにしてもよい。要は、エンジン始動時のエンジンフリクションに応じたＮＥ上昇度合を燃料噴射制御に反映させるものであればよい。

【００５７】（別の形態５）前記図２のＴＡＵ算出ルーチンでは、完爆判定回転数ＳＴＢＮＥを水温Ｔｗに応じて可変に設定していたが、この完爆判定回転数ＳＴＢＮＥを固定値とする。この場合、ＳＴＢＮＥ値の検索処理が省略されることで、ＥＣＵ３０による演算負荷が軽減できる。

【図面の簡単な説明】

【図１】発明の実施の形態における内燃機関の燃料噴射制御装置の概要を示す全体構成図。

【図２】ＴＡＵ算出ルーチンを示すフローチャート。

【図３】水温と完爆判定回転数との関係を示す図。

【図４】水温と始動時燃料量との関係を示す図。

【図５】エンジン回転数及び水温と回転補正係数ＫＮＥＳＴとの関係を示す図。

【図６】実施の形態における作用を具体的に説明するためのタイムチャート。

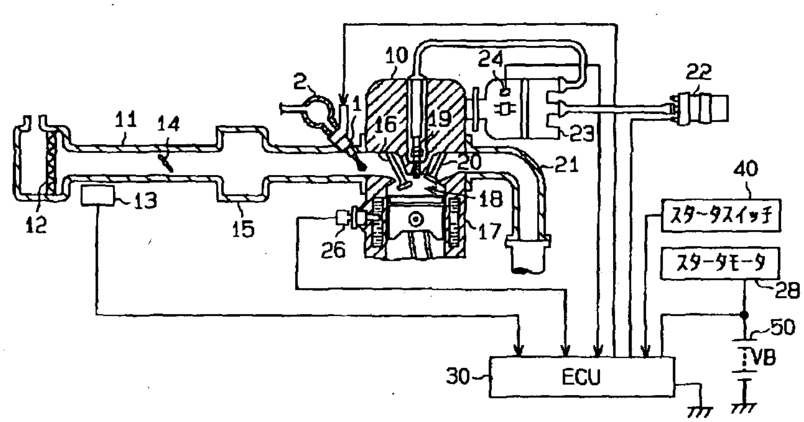
【図７】別の形態において、サイクル数及び水温と補正係数ＫＳＹＣＳＴとの関係を示す図。

【図８】別の形態において、吸気バルブ開弁時間及び水温と補正係数ＫＶＳＴとの関係を示す図。

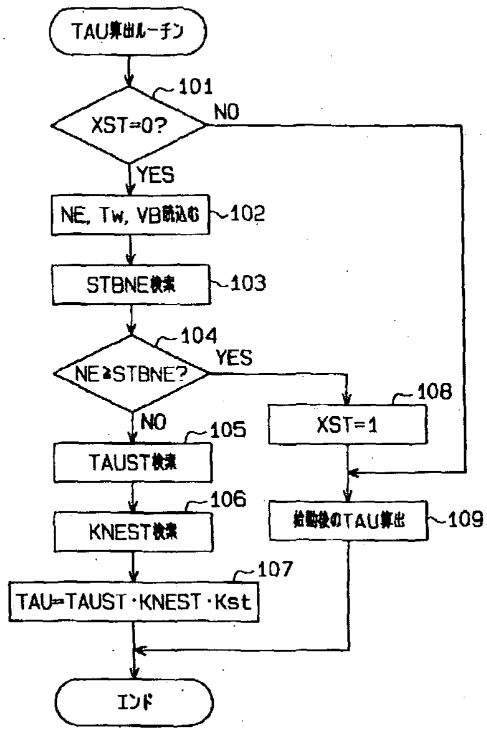
【符号の説明】

１…インジェクタ、１０…エンジン（内燃機関）、１６…吸気バルブ、２４…回転数検出手段としての回転数センサ、２６…温度検出手段としての温度センサ、３０…始動時燃料量算出手段，第１の補正手段，第２の補正手段，燃料量補正手段，完爆判定手段，完爆判定値設定手段としてのＥＣＵ（電子制御装置）。

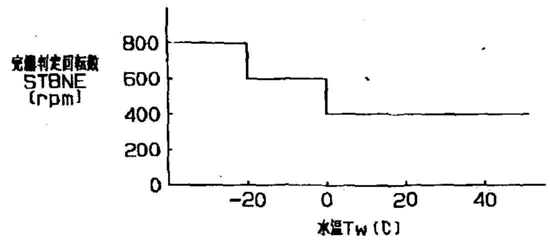
【図１】



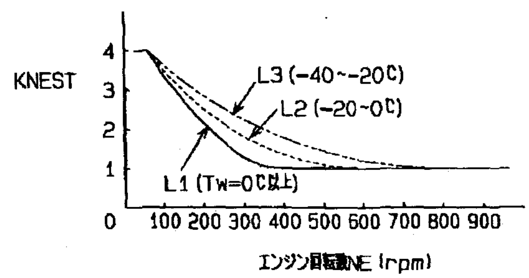
【図２】



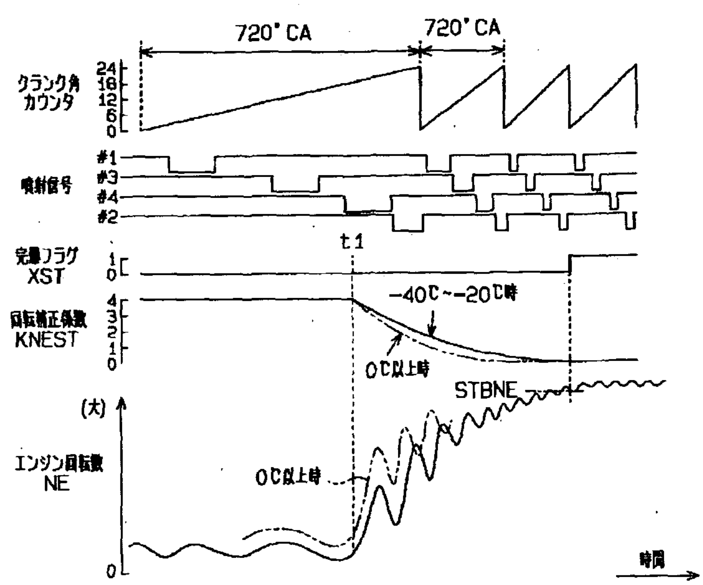
【図３】



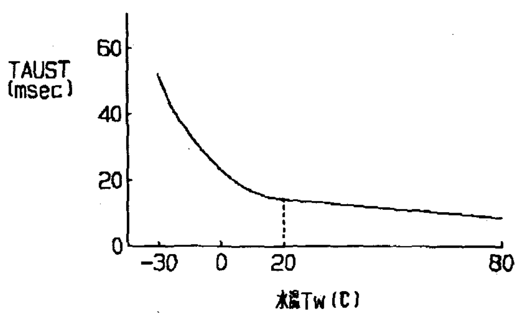
【図５】



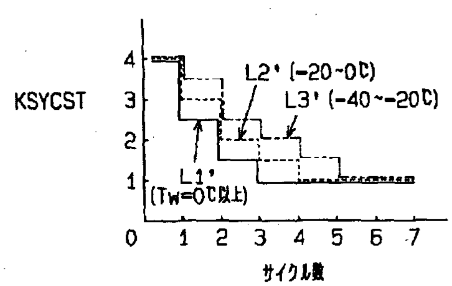
【図６】



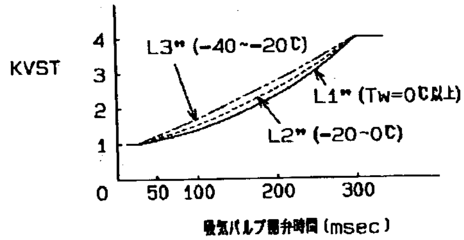
【図４】



【図７】



【図8】


KVST
L3** (−40~−20℃)
L1** (Tw=0℃以上)
L2** (−20~0℃)
4
3
2
1
0
50
100
200
300
吸気バルブ開弁時間 (msec)